4-2005

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Journal of Agricultural and Applied Economics, 37,1(April 2005):145–160

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Forward pricing behavior of random samples of Indiana, Nebraska, and Mississippi crop producers was analyzed using Heckman's two-step limited information maximum likelihood estimation procedure. Producers who forward priced during the 1995–1998 period generally expected to forward price in 1999 using similar techniques. Probit models were estimated for cash forward contracts and taking a direct position in futures or options separately and combined. Results provide limited support for the hypothesis that forward pricing should be analyzed as an adoption decision. Variables reflecting risk attitudes do affect the decision to use forward pricing, while variables related to economic position affect the level of forward pricing.

Key Words: forward contracts, futures, grain marketing, Heckman procedure

JEL Classifications: Q130, Q120

Understanding of the factors that influence producers' marketing behavior, including the choice of pricing alternatives, is an ongoing area of research for agricultural economists. Marketing education programs commonly encourage grain producers to use preharvest forward pricing as a way to manage price risk by avoiding selling at harvest. However, producers differ in their attitudes toward forward pricing and their willingness to use futures, options, and cash forward contracts. Empirical studies have found that an increasing percentage of producers have adopted forward pricing techniques over time. For example, Hill reported that 4% of surveyed Kansas grain farmers hedged and that 12% used forward pricing in the early 1970s. Asplund, Forster, and Stout found that 42% of Ohio grain producers surveyed in 1986 used forward pricing, while only 7% of the respondents used hedging. Goodwin and Schroeder, in a 1992 survey of Kansas producers, found that 45% used forward contracting, 11% used hedging, and 19% used options to manage price risk in their farming operation. Sartwelle et al. found that 70% of Kansas, Iowa, and Texas producers surveyed in the late 1990s used forward con-

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Journal Paper No. 17,439, Office of Agricultural Research Program, Purdue University. This research was partially supported by a Risk Management Agency (RMA) grant through the Cooperative State Research, Education, and Extension Service (CSREES), U.S. Department of Agriculture. The authors wish to thank Douglas Miller and two anonymous reviewers of the *Journal* for their helpful comments and suggestions on an earlier version.

tracts and that 52% used futures and options contracts.

Sartwelle et al. used multinomial logit models to categorize producers' grain marketing orientation and analyze the associated socioeconomic characteristics. Other studies have used Tobit models (Goodwin and Schroeder; Musser, Patrick, and Eckman; Sartwelle et al.; Shapiro and Brorsen) to analyze the effect of socioeconomic variables on the adoption and use of forward pricing. Tobit models account for censoring of observations at zero (no forward pricing) but also impose a restriction on economic behavior. Park and Florkowski indicate that any factor that determines the probability of an individual forward pricing also has the same impact on the amount forward priced. Transactions costs, such as the costs that Townsend and Brorsen have identified as being associated with using futures, options, and forward contracts, are not reflected in a Tobit model. An alternative model, the Heckman two-step procedure, is used in this study to analyze the possible effects of these transactions costs.

Previous studies of marketing behavior have used nonrandom samples of producers (Goodwin and Schroeder; Musser, Patrick, and Eckman; Sartwelle et al.; Shapiro and Brorsen). Those studies in which random samples have been used (Asplund, Forster, and Stout; Hill) have been limited to a single state. This study uses large, stratified random samples of producers in multiple states to determine if socioeconomic variables have separate effects on the decision whether to forward price and on the level of preharvest forward pricing of soybeans and corn for the 1999 crop year. Forward pricing through the use of cash forward contracts or by taking a direct position with a futures or options contract is first considered separately, and then all forms of forward pricing are combined.

Conceptual Background

Previous studies of the use of marketing techniques have treated the decision to use a particular technique as an adoption of technology decision (e.g., Goodwin and Schroeder). The theory of adoption or diffusion of a new technology or innovative practice suggests that the rate of adoption is influenced both by characteristics of the new technology and by the adopting agent (Rogers). Use of forward pricing techniques is commonly portrayed as being positive for producers—potentially profit-enhancing or risk-reducing. Brorsen and Anderson argue, "We have oversold our ability to forecast prices and oversold the benefits of hedging and forward contracting" (p. 90). Furthermore, there is a considerable debate on the effectiveness of preharvest marketing strategies (Wisner, Blue, and Baldwin; Zulauf and Irwin). Thus, a producer's views on the characteristics or effectiveness of marketing techniques in meeting their own marketing objectives would be expected to have major impacts on their adoption and use of forward marketing techniques.

Many studies have focused on the importance of human capital (formal education and other training) of the operator in the adoption of technology. More highly educated individuals are more likely to adopt the new technology. Older, more experienced producers may be in a stronger financial position and more willing to adopt the new technique. However, age and experience may also result in individuals being less willing to change. Risk attitudes are also expected to influence use, but empirical evidence is mixed. Musser, Patrick, and Eckman found that producers perceive forward pricing as reducing their risk, while Goodwin and Schroeder found that producers with a stated preference for risk were more likely to forward price. Other characteristics of the farm operation, such as size, financial position, specialization, expected variability of prices and yields, and use of other risk management techniques, would be expected to affect the use of forward pricing techniques. Larger or more specialized farms may be able to spread the fixed costs associated with forward pricing over more units of output. Finally, external factors, such as a lender's attitude, may also impact the use of forward pricing.

Data and Procedures

The data used for this study are from a stratified, random survey of crop producers in Indiana, Mississippi, Nebraska, and Texas conducted through the National Agricultural Statistics Service prior to 1999 spring planting (Coble et al.). Four gross income categories are defined: \$25,000—99,999, \$100,000—\$249,999, \$250,000—\$499,999, and \$500,000 or more. A questionnaire was mailed to each producer, followed by a postcard reminder, and then a second questionnaire. About 30% of the producers contacted completed questionnaires. There were 466 responses from Indiana, 504 from Mississippi, and 300 from Nebraska. The observations from Texas are excluded from this study because corn and soybeans were not the crops for which marketing information was obtained. Information about corn marketing was not collected from Mississippi producers, and they are excluded from the analysis of forward pricing of corn.

Heckman's two-step limited information maximum likelihood estimation procedure is used to evaluate the effect of various socioeconomic variables on the decision to forward price and the percentage of expected soybean and corn production forward priced by producers in 1999. LIMDEP was used to estimate the models. Each model is composed of two equations: a selection equation and a linear regression (Greene, pp. 983–84).

$$(1) \quad z_i^* = \gamma' w_i + u_i,$$

$$(2) \quad y_i = \beta' x_i + \varepsilon_i.$$

The selection equations are probit models that determine the effect of independent variables, w_i, on the probability of respondent i choosing to forward price soybeans or corn prior to harvest (Equation [1]). The probit models select the observations that are in the samples estimated by the linear regression models. The observation y_i is in the sample if z_i^* is greater than zero. The linear regression models explain the effect of the independent variables, x_i, on the percentage of expected soybean or corn production that is forward priced prior to harvest (Equation [2]). Maximum likelihood estimation is used because the general Heckman two-step procedure is consistent but not efficient (Greene, p. 984).

Empirical Model

Use of forward pricing techniques has been treated as an adoption of technology decision in previous studies. As discussed previously, characteristics of the producer and the farm unit would be expected to affect the use of forward pricing. Shapiro and Brorsen analyzed the percentage of the crop hedged by large-scale grain producers attending the 1985 Purdue University Top Farmer Crop Workshop and found that experience (age) had a statistically significant negative effect on the percent hedged. Musser, Patrick, and Eckman also found that age had a negative effect on the forward pricing of corn, while Sartwelle et al. found that experience had a negative effect on the use of futures. Thus, a negative coefficient is expected for AGE, both for the decision to use forward pricing and for the percent forward priced.

Previous studies have not been consistent on the effect of education on the use of forward pricing. Goodwin and Schroeder and Musser, Patrick, and Eckman both encountered a positive effect, while Shapiro and Brorsen found a negative relationship. Asplund, Forster, and Stout found that producers attending farm organization meetings tended to use forward pricing and hedging. It is hypothesized that better-educated producers are more likely to study the futures market and evaluate several marketing strategies. A dummy variable, EDUC, equals one if the producer has at least some postsecondary education, reflecting the categorical data collected, and positive coefficients are expected for both the decision whether to use forward pricing and the percent forward priced.

The total crop acres owned, rented, and managed for someone else, CROPAC, is a measure of the scale of the farming operation. The fixed cost component of forward pricing through futures and options, gathering information, finding a broker, and making margin

calls may be quite large (Townsend and Brorsen). Large-scale producers are better able to spread the fixed costs of forward pricing and may be better able to match production levels hedged to futures contracts. Shapiro and Brorsen found that crop acres had a significantly positive effect on use of hedging. Goodwin and Schroeder had similar results for forward pricing of soybeans. Using gross receipts as a measure of size, Asplund, Forster, and Stout and Musser, Patrick, and Eckman also found positive relationships with forward pricing. Thus, a positive relationship is hypothesized between the number of crop acres in the farming operation and whether forward pricing is used.

Asplund, Forster, and Stout found that the use of consultants affected the use of forward pricing and hedging. In this study, a dummy variable, MKTADVIS, equals one if the respondent used marketing consultants or computerized information sources. Producers who use consultants or other sources of information are expected to use forward pricing, and a positive coefficient is expected for the decision to use forward pricing as well as for the percent forward priced.

The survey asked producers about their expectations for the 1999 harvest cash prices of corn and soybeans and the possible price variability. Producers indicated the price that they would be most likely to receive at harvest. They also gave estimates of a low and high price where there is only a 10% chance that they would receive prices below or above these levels, respectively. A producer's expected soybean and corn prices were calculated as the sum of the 10th and 90th percentile prices and two times the most likely price divided by four (Keefer and Bodily). Producers with low harvest price expectations may perceive only limited downside price risk and might not forward price.[1] However, producers expecting a high harvest price may be more likely to forward price a higher percentage of their expected production. Thus, a producer's price expectations are expected to affect both the use and the level of forward pricing.[2]

Producers' attitudes toward risk are also expected to affect forward pricing decisions. Goodwin and Schroeder found that producers who preferred risk were more likely to use forward pricing than risk-averse producers because production risk affects the effectiveness of forward pricing in reducing total farm income variability. However, Musser, Patrick, and Eckman found that producers viewed forward pricing as risk reducing. The survey also asked producers to rate sources of risk in terms of their potential to affect farm income. A five-point Likert-type scale is used where a one indicates a small effect and a five indicates a large effect on farm income. The variable PRCRISK indicates a producer's perception of the effect of price variability on farm income variability. A positive coefficient is expected for PRCRISK for the decision to forward price. A similar Likert-type scale is used where a one indicates that the producer is very unwilling to accept risk and a five indicates that the producer is very willing to accept risk, RISKWILL. Following Musser, Patrick, and Eckman, it is expected that producers who were less willing to accept risk would be more likely to forward contact.

Producers were asked to rate, on five-point Likert-type scales, their comfort with using futures and options, FUTURE, as well as using cash and other forward contracting methods, FORWARD, to reduce price risk. A one indicates that producers are not comfortable with the technique, while a five indicates that producers are very comfortable. Producers that are more comfortable with futures and options or with cash and other forward contracting are expected to be more likely to use the forward pricing technique.[3]

[1] The preplanting period futures prices for December 1999 corn and November 1999 soybeans were substantially below the preplanting period prices of the prior 3 years.

[2] A reviewer noted that inability of the producer to lock in a Loan Deficiency Payment may be a major deterrent to a producer forward pricing a commodity before harvest. Future research should focus on the producer's harvest price expectations relative to preharvest prices.

[3] There is possible simultaneity in comfort in using marketing tools, use of a marketing advisor, and forward pricing, which is not considered in this analysis.

A dummy variable, LENDER, equals one if the producer's primary lender recommends the use of forward pricing. Perhaps producers use forward pricing because it is part of the loan covenant. A positive coefficient is expected on whether forward pricing is used. The survey asked producers to indicate the percentage of the total dollars invested in the farming operations that are borrowed, PCTDEBT. The effect of leverage on forward pricing is unclear. If forward pricing is risk reducing, then it would be expected that greater use of forward pricing would be associated with higher percent debt or leverage. Studies by Shapiro and Brorsen, Goodwin and Schroeder, and Musser, Patrick, and Eckman found positive relationships between level of debt and forward pricing.

The percentage of total crop acres planted to either corn, PCTCNAC, or soybeans, PCTSBAC, in 1999 measures the importance of each enterprise to the individual farm businesses. Producers that plant a larger percentage of their crop acres to corn or soybeans would be likely to forward price a higher percentage of production because business risk will have a greater effect on gross farm income variability. A positive relationship, similar to that encountered by Sartwelle et al. is expected between the percentage of total crop acres planted to corn or soybeans and the use of forward pricing.

The survey also asked producers to indicate if they were purchasing crop insurance for the 1999 crop year. Dummy variables, CNINSUR and SBINSUR, for corn and soybeans, respectively, equal one if a producer had purchased catastrophic coverage, multiple peril, crop revenue coverage, income protection, revenue assurance, or group risk plan insurance.[4] Producers having crop insurance have a willingness to use financial instruments to manage risk and may be more willing to forward price a larger portion of production. Sartwelle et al. found that crop insurance had a positive effect on the use of forward pricing, so a positive coefficient is expected.

The percentage of total farm income generated by livestock production, PCTLVST, is included in the corn forward pricing model. Livestock producers may feed the corn crop instead of marketing the grain; thus, the percentage of corn forward priced is reduced. The variable PCTLVST is included in the linear regression model, and a negative coefficient is expected.

Dummy variables are used to identify whether the respondents are from Mississippi or Nebraska. Geographic location affects basis, and basis may affect the potential effectiveness of hedging and forward pricing. For example, Mississippi producers have access to the Gulf and export markets and may experience a different basis risk than producers in Indiana and Nebraska. Similarly, producers in Indiana have access to the Ohio River and Lake Michigan and a narrower basis than Nebraska producers. Sartwelle et al. found that location had a statistically significant effect on the use of futures and options.

The dependent variables for the probit models are binary variables set equal to one if producers planned to forward price corn or soybeans in 1999. The dependent variables for the linear regression models are the percentages of expected corn and soybean production forward priced. Forward pricing through the use of cash forward contracts and by taking a direct position in a futures or options contract is first considered separately, and then all forms of forward pricing are combined.

Survey Results

The sample respondents from Mississippi farmed more acres, on average, than the re-

[4] There is considerable variation in the level of participation in crop insurance and the type of coverage used. In 1998, the year preceding the survey, about 45% of the Indiana corn acreage and 47% of the soybean acreage was insured. Actual Production History (APH) yield insurance was used for 67% and 74% of the insured corn and soybeans, respectively. Crop Revenue Coverage (CRC) was used for 20% of the corn acreage and 10% of the soybean acreage. Although 87% of the soybean acreage in Mississippi was insured, APH was used for over 99%. In Nebraska, 76% and 65% of the corn and soybeans acreages, respectively, were insured. APH was used for 62% of the corn and 58% of the soybeans with CRC accounting for the rest.

Table 1. Means and Standard Deviations (in parentheses) of Descriptive Statistics of Respondents' Farming Operations

	Indiana	Nebraska	Mississippi
Total acres in farm operation	1,118.2[c]	1,718.8[b]	2,155.2[a]
	(1,034.5)	(2,155.2)	(2,177.6)
Total crop acres in farming operation	1,029.5[b]	1,116.2[b]	1,852.9[a]
	(965.9)	(969.1)	(1,986.6)
Total crop acres owned	378.0[b]	480.2[b]	706.1[a]
	(470.2)	(530.1)	(1,124.2)
Percentage of gross household income from farming	69.2[b]	81.1[a]	71.1[b]
	(30.8)	(24.2)	(29.4)
Percentage of gross farm income from livestock production	14.1[b]	28.4[a]	6.6[c]
	(24.4)	(32.2)	(16.5)
Percentage of gross household income from off-farm employment	23.3[a]	16.3[b]	19.2[b]
	(28.9)	(24.2)	(27.6)

Note: Mean values of a variable for states with the same superscript are not significantly different at the 5% level.

spondents from Indiana and Nebraska (Table 1). The average farm size was 2,155 acres for Mississippi, 1,718 acres for Nebraska, and 1,118 acres for Indiana respondents with the means significantly different at the 5% level. Similarly, the average total crop acres and owned crop acres for Mississippi respondents were significantly different from both the average total and owned crop acres for respondents from Indiana and Nebraska (Table 1).

On average, the Nebraska respondents received more of their household gross income from farming operations (Table 1). Nebraska respondents indicated that 81% of their gross household income was from farming operations, while 71% and 69% of Mississippi and Indiana respondents' household income were from farming operations, respectively. The percentage of gross farm income from livestock enterprises was greatest for Nebraska respondents (28%) compared to 14% for Indiana and 7% for Mississippi, with the means significantly different at the 5% level. Indiana respondents had the largest average percentage of gross household income from off-farm employment (23%) and were significantly different from Nebraska (16%) and Mississippi (19%) respondents.

Twenty-eight percent of soybean producers and 32% of the corn producers had not forward priced any of their soybean and corn production in 1995–1998 (Table 2). Fifty-seven percent of corn producers and 56% of the soybean producers responding did forward price both before and after harvest in the 1995–1998 period. Only a small percentage of the respondents forward priced just before harvest or only after harvest, with forward pricing just after harvest being more common. Cash forward contracts were the more popular method of forward pricing both before and after harvest by substantial margins (Table 2).

Table 3 reports the expected pricing behavior for corn and soybean producers in 1999 compared with their pricing behavior for the 1995–1998 period. Twenty-five percent and 27% of the soybean and corn respondents, respectively, did not use forward pricing in either 1995–1998 or 1999. On the other hand, over 37% and 45% of soybean and corn producer respondents, respectively, indicated that they both used forward pricing in 1995–1998 and expected to forward price in 1999. Another 20% of soybean producers and 19% of corn producers indicated that they expected to use forward pricing in 1999 although they had not used forward pricing in 1995–1998. Only about 5% of soybean producers and 1% of corn producers responded that they would not use forward pricing in 1999 even though they used the technique in 1995–1998.

Table 3 also indicates that those producers who had forward priced in both periods tended to use the same forward pricing method. For

Table 2. Number and Percentage of Soybean and Corn Producers Using Forward Pricing, 1995–1998

	Futures and Options	Forward Contracts	Both	Total
		Soybeans (N = 1,145)		
No forward pricing	—	—	—	318 (27.8%)
Priced before harvest only	11 (1.0%)	47 (4.1%)	11 (1.0%)	69 (6.0%)
Priced after harvest only	16 (1.4%)	74 (6.5%)	11 (1.0%)	101 (8.8%)
Priced before and after harvest	90 (7.9%)	353 (30.8%)	214 (18.7%)	657 (57.4%)
		Corn (N = 737)		
No forward pricing	—	—	—	215 (31.9%)
Priced before harvest only	7 (0.9%)	31 (4.2%)	7 (0.9%)	45 (6.1%)
Priced after harvest only	10 (1.4%)	47 (6.4%)	5 (0.7%)	62 (8.4%)
Priced before and after harvest	43 (5.8%)	224 (30.4%)	148 (20.1%)	415 (56.3%)

example, 49% of the 426 soybean producers indicated they had used forward contracts in 1995–1998 and expected to use forward contracts in 1999. For the 336 corn producers, it was 52%. Similarly, 9% and 10% of soybean and corn producers took direct positions in the market in both 1995–1998 and 1999. Only 2% of soybean respondents and 3% of corn respondents switched from a direct position to a forward contract, while 4% and 3% switched from a forward contract to a direct position in the market (Table 3).

Fifty-eight percent of the soybean producers expected to forward price soybeans, and nearly 66% of the corn producers expected to forward price corn in 1999 (Table 4). On average, these producers anticipated forward pricing about 47% and 43% of their expected soybean and corn production, respectively, before harvest. However, nearly 32% of soybean producers and 29% of corn producers indicated that they would not forward price any of their expected production in 1999 (Table 4).

Descriptive statistics of the independent and dependent variables used in this study as well as the responses for each state are reported in Table 5. The average age of the respondents was 52 years, ranging from 51 for Nebraska respondents to 53 for Indiana respondents. Sixty-three percent of the respondents had some postsecondary education. Seventy-two percent of the respondents from Mississippi had some postsecondary education, which is significantly greater than the respondents from Indiana (57%) and Nebraska (59%). Soybeans were an important part of the farm business, as 42% of the crop acres were planted to soybeans in 1999. However, respondents from Nebraska reported a significantly smaller percentage of total crop acres planted to soybeans (27%) compared to Indiana (46%) or Mississippi (48%). Similarly, 34% of the crop acres were planted to corn with the respondents from Mississippi reporting the smallest percentage (9%) compared to Indiana (47%) or Nebraska (54%). While the respondents are from large farming operations (Table 1), the average percent debt for all respondents is about 35%. However, Mississippi respondents reported greater leverage (50%) than the other two states.

Forty-five percent of the respondents in the

Table 3. Soybean and Corn Producers' Pricing Behavior in 1999 Versus 1995–1998

	Total Soybean	Total Corn
Past and current forward pricing	N = 1,145	N = 737
Did not forward price in 1995–1998 or in 1999	285 (24.9%)	198 (26.9%)
Priced before harvest in 1995–1998 and in 1999	426 (37.5%)	336 (45.6%)
Did not forward price in 1995–1998 but did in 1999	230 (20.0%)	139 (18.9%)
Priced before harvest in 1995–1998 but did not in 1999	66 (5.7%)	9 (1.2%)
Incomplete information	263 (12.1%)	84 (7.5%)
Form of forward pricing	N = 426	N = 336
Took a direct position in 1995–1998 and in 1999	39 (9.2%)	34 (10.1%)
Used forward contracts in 1995–1998 and in 1999	207 (48.6%)	174 (51.8%)
Took a direct position and used forward contracts both in 1995–1998 and in 1999	17 (4.0%)	21 (6.3%)
Took a direct position in 1995–1998 and used forward contracts in 1999	9 (2.1%)	9 (2.7%)
Used forward contracts in 1995–1998 and took a direct position in 1999	15 (3.5%)	9 (2.7%)
Took a direct position and used forward contracts in 1995–1998 and took a direct position in 1999	41 (9.6%)	44 (13.1%)
Took a direct position and used forward contracts in 1995–1998 and used forward contracts in 1999	39 (9.2%)	30 (8.9%)
Took a direct position in 1995–1998, while in 1999 took both a direct position and used forward contracts	2 (0.5%)	0 (0%)
Used forward contracts in 1995–1998, while in 1999 took both a direct position and used forward contracts	7 (1.6%)	3 (0.9%)
Incomplete information	50 (11.7%)	12 (3.6%)

Table 4. Producers' Expected Forward Pricing Behavior in 1999

	Soybeans (N = 1,145)	Corn (N = 737)
Number and percentage of respondents expecting to price before 1999 harvest	668 (58.3%)	484 (65.7%)
Average percentage of 1999 expected production priced before harvest	46.7%	42.4%
Number and percentage of repondents not pricing before 1999 harvest	362 (31.6%)	211 (28.6%)
Number and percentage not answering the question completely	115 (10.0%)	42 (5.1%)

Table 5. Mean and Standard Deviation of Variables Used in Heckman's Two-Step Regression Model for the Percentage of Expected Corn and Soybean Production Forward Priced

Variable	Description	Combined Data	Indiana	Nebraska	Mississippi
AGE	Age of primary decision maker	52.20	53.01[a]	50.85[b]	52.25[ab]
		(12.25)	(12.25)	(12.20)	(12.24)
EDUC	Dummy variable representing postsecondary education	0.63	0.57[b]	0.59[b]	0.72[a]
		(0.48)	(0.50)	(0.49)	(0.45)
CROPAC	Total crop acres in farming operation	1,375.45	1,029.54[b]	1,116.07[b]	1,852.89[a]
		(1,507.71)	(965.89)	969.10)	(1,986.64)
MKTADVIS	Dummy variable representing the use of market consultants or computerized information services	0.45	0.50[a]	0.46[ab]	0.40[b]
		(0.50)	(0.50)	(0.50)	(0.49)
MEANCPRC	Respondent's expectation of most likely harvest time corn price	2.00	2.06[a]	1.90[b]	—
		(0.27)	(0.30)	(0.19)	
MEANSPRC	Respondent's expectation of most likely harvest time soybean price	4.94	4.88[b]	4.69[c]	5.13[a]
		(0.46)	(0.42)	(0.39)	(0.46)
PRCRISK	Self-assessed rating of the effect of price risk on total farm income variability	4.57	4.50[b]	4.55[ba]	4.64[a]
		(0.77)	(0.76)	(0.79)	(0.76)
RISKWILL	Self-assessed rating of willingness to accept risk in farm business relative to other farmers	3.22	3.25[a]	3.10[b]	3.32[a]
		(0.90)	(0.88)	(0.88)	(0.94)
FUTURE	Self-assessed comfort with using futures and options	2.57	2.51[a]	2.66[a]	2.58[a]
		(1.35)	(1.32)	(1.41)	(1.33)
FORWARD	Self-assessed comfort with using forward contracting	3.60	3.56[ab]	3.44[b]	3.71[a]
		(1.37)	(1.35)	(1.46)	(1.31)
LENDER	Dummy variable equaling one if lender encourages forward pricing	0.32	0.26[b]	0.39[a]	0.34[a]
		(0.47)	(0.44)	(0.49)	(0.48)
PCTDEBT	Percentage of total dollars invested in farm business that is borrowed	35.53	23.11[c]	29.95[b]	49.97[a]
		(31.81)	(22.47)	(25.09)	(36.46)
PCTCNAC	Percentage of total crop acres planted to corn	0.34	0.47[b]	0.55[a]	0.09[c]
		(0.27)	(0.16)	(0.22)	(0.15)
PCTSBAC	Percentage of total crop acres planted to soybeans	0.42	0.46[a]	0.27[b]	0.48[a]
		(0.28)	(0.27)	(0.19)	(0.30)
PCTSB	Percentage of expected soybean production forward priced in 1999	30.28	27.09[b]	24.47[b]	36.97[a]
		(29.78)	(26.50)	(27.83)	(32.83)
PCTCN	Percentage of expected corn production forward priced in 1999	29.55	30.48[a]	28.07[a]	—
		(27.09)	(26.46)	(28.04)	
PCTLVST	Percent of farm income from livestock production	14.70	14.07[b]	28.39[a]	6.59[c]
		(25.46)	(24.38)	(32.18)	(16.48)
SBFRWD	Binary variable equal to one if forward priced soybeans in 1999	0.65	0.67[a]	0.58[b]	0.66[ab]
		(0.48)	(0.47)	(0.49)	(0.48)
CNFRWD	Binary variable equal to one if forward priced corn in 1999	0.70	0.74[a]	0.63[b]	—
		(0.46)	(0.44)	(0.48)	

Note: Mean values of a variable for states with the same superscript are not significantly different at the 5% level.

combined data set used marketing consultants or subscribed to computerized information services (Table 5). A greater percentage of Indiana producers (50%) used marketing consultants or computerized information services than Mississippi producers (40%). Thirty-two percent of the respondents in the combined data set indicated that their primary lender en-

couraged the use of forward pricing, and this ranged from 26% in Indiana to 38% for Nebraska.

Eighty-two percent of the respondents from Mississippi and Nebraska purchased crop insurance compared to 57% of Indiana respondents (Table 5). Mississippi respondents also perceived yield risk to have a greater effect on their farm income variability than respondents from Indiana and Nebraska. Similarly, Mississippi respondents also perceived price variability to have a greater effect on their farm income variability than those from Indiana and Nebraska.

Econometric Results

Tables 6 and 7 present the results from the Heckman two-stage limited information maximum likelihood models of forward pricing of 1999 corn and soybeans. Table 6 considers only cash forward contracts, while Table 7 considers the taking of a direct position in a futures or options contract. Table 8 presents the results for all forward pricing methods combined.

In contrast to many previous studies, neither age, AGE, nor education (EDUC) have significant effects on the use or level of cash forward contracts for corn or soybeans[5]. Perhaps as forward pricing becomes common, the factors typically associated with early adoption are of less importance. Size of the operation, CROPAC, does not have the expected positive effect on the use of forward pricing, suggesting the fixed costs of using cash forward contracts may be low. However, larger farms do forward contract significantly more of both corn and soybeans. Use of a marketing consultant or a computerized information service, MKTADVIS, had positive and statistically significant effects on both the use of forward contracting and the level of use for both corn and soybeans. Higher harvest price expectations, MEANCPRC and MEANSPRC, tended to result in both a lower probability of using forward contracting and a lower level of use, but only the lower level of use for soybeans was statistically significant.

Most of the variables hypothesized to affect the use of cash forward contracts had statistically significant effects. Concern about price risk, PRCRISK; comfort in using forward contracting, FORWARD; and having a lender who encouraged use of forward contracting, LENDER, had positive significant effects for corn. It is interesting to note that increased comfort in using futures, FUTURE, had statistically significant negative effects on the use of cash forward contracts for both corn and soybeans. This suggests that producers do view the forms of contracting as substitutes in their marketing.

Increased leverage, PCTDEBT, was associated with significantly higher levels of forward contracting of both corn and soybeans. Specialization in a crop, PCTCNAC and PCTSBAC, and use of crop insurance, CNINSUR and SBINSUR, lead to higher levels of forward contracting but were not statistically significant. Larger percentages of farm income from livestock, PCTLVST, lead to significantly lower levels of forward contracting of corn. The dummy variables for states indicate that Nebraska producers are significantly less likely than Indiana producers to forward contract corn, while Mississippi producers contract a significantly higher percentage of their soybeans than Indiana or Nebraska producers.

Table 7 results for producers taking a direct position with a futures or options contract are generally similar to results for cash forward contracting in Table 6. The lender's attitude, comfort in using futures and options, and attitude toward risk all had positive and significant effects on the use of futures and options for forward pricing. Again, the use of a marketing consultant or a computerized information service positively affected both the use and the level of forward pricing. Use of crop insurance by corn producers had a statistically significant positive impact on the level of forward pricing, while a higher percentage of income from livestock decreased forward pricing. In contrast to cash forward contracting,

[5] An alternative specification included whether a producer had attended a training program on a pricing technique in the past 3 years, but it was not significant.

Table 6. Coefficients and Standard Errors for Heckman's Two-Step Regression for the Dependent Variable of Producers Using Forward Contracts

	Corn		Soybeans	
Variable	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced
INTERCEPT	−1.1212	36.7875**	0.1398	35.0549***
	(0.7452)	(14.3223)	(0.6428)	(12.5877)
AGE	−0.0076	−0.1586	−0.0025	0.0537
	(0.0054)	(0.1207)	(0.0042)	(0.0965)
EDUC	−0.0786	0.9256	−0.0597	−0.0930
	(0.1274)	(2.7608)	(0.1058)	(2.4770)
CROPAC	0.0001	0.0020*	0.0000	0.0015**
	(0.0001)	(0.0012)	(0.0000)	(0.0007)
MKTADVIS	0.3680***	8.4396***	0.2231**	11.2771***
	(0.1348)	(2.9519)	(0.1085)	(2.2782)
MEANCPRC	−0.1087	−4.5443	—	—
	(0.2407)	(5.7230)		
MEANSPRC	—			−4.2152*
			(0.1024)	(2.4093)
PRCRISK	0.1675**		−0.0010	
	(0.0825)		(0.0654)	
RISKWILL	−0.0369		−0.0890	
	(0.0693)		(0.0555)	
FUTURE	−0.1314**		−0.2348***	
	(0.0542)		(0.0427)	
FORWARD	0.4412***		0.4389***	
	(0.0570)		(0.0465)	
LENDER	0.2924**		−0.0230	
	(0.1360)		(0.1015)	
PCTDEBT		9.6297*		8.2454**
		(5.7419)		(3.5663)
PCTCNAC		9.3501		—
		(7.5578)		
PCTSBAC		—		3.6892
				(3.9986)
CNINSUR		3.9053		—
		(2.7161)		
SBINSUR		—		0.6988
				(2.7651)
PCTLVST		−14.7909***		—
		(5.3248)		
NEBRASKA	−0.4665***	1.6520	−0.0802	0.8142
	(0.1254)	(2.8924)	(0.1210)	(3.1787)
MISSISSIPPI	—	—	−0.1594	12.6303***
			(0.1162)	(2.9435)
N	604	364	860	522
Chi-square	175.5039	55.3026	131.1389	84.1662
P-VALUE	0.0000	0.0000	0.0000	0.0000

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7. Coefficients and Standard Errors for Heckman's Two-Step Regression for the Dependent Variable of Producers Taking a Direct Position in the Futures/Options Market

	Corn		Soybeans	
Variable	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced
INTERCEPT	−1.5154*	53.5537*	−0.9889	50.9822*
	(0.8132)	(30.0130)	(0.7084)	(27.0465)
AGE	0.0002	−0.2458	−0.0074	−0.0193
	(0.0061)	(0.2686)	(0.0049)	(0.1875)
EDUC	0.0897	0.9765	−0.2171	0.3985
	(0.1400)	(5.3057)	(0.1209)	(5.0101)
CROPAC	−0.0001	0.0019	0.0000	0.0006
	(0.0001)	(0.0028)	(0.0000)	(0.0014)
MKTADVIS	0.2709*	8.9285	0.0161	18.1996***
	(0.1484)	(5.5603)	(0.1247)	(4.7438)
MEANCPRC	−0.1120	−11.2528	—	—
	(0.2530)	(10.3824)		
MEANSPRC	—	—	0.0448	−6.0930
			(0.1126)	(4.3285)
PRCRISK	0.0469		−0.0409	
	(0.0934)		(0.0710)	
RISKWILL	−0.2229**		−0.0240	
	(0.0742)		(0.0616)	
FUTURE	0.5429***		0.3665***	
	(0.0610)		(0.0495)	
FORWARD	−0.0541		−0.0901*	
	(0.0663)		(0.0532)	
LENDER	0.3921***		0.2937*	
	(0.1376)		(0.1102)	
PCTDEBT		1.5852		16.8415**
		(9.8000)		(7.3626)
PCTCNAC		15.2088		—
		(12.8855)		
PCTSBAC		—		−0.1577
				(9.8264)
CNINSUR		9.5874**		—
		(4.6569)		
SBINSUR		—		0.6192
				(5.1166)
PCTLVST		−21.8279***		—
		(7.3923)		
NEBRASKA	−0.1369	0.8856	−0.1659	8.7867
	(0.1348)	(4.8040)	(0.1372)	(5.5861)
MISSISSIPPI	—	—	−0.0690	1.9780
			(0.1302)	(5.2368)
N	604	159	860	203
Chi-square	164.1812	40.2466	93.0871	44.8164
P-VALUE	0.0000	0.0000	0.0000	0.0000

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 8. Coefficients and Standard Errors for Heckman's Two-Step Regression for the Dependent Variable of Producers using Forward Contracts or a Direct Position in the Futures/Options Market

	Corn		Soybeans	
Variable	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced	Probability of Forward Pricing Grain	Percent of Expected Production Forward Priced
INTERCEPT	−1.0351	41.3180***	0.6227	37.1478***
	(0.7775)	(13.5664)	(0.7064)	(11.6143)
AGE	−0.0057	−0.1697	−0.0108**	0.0695
	(0.0058)	(0.1147)	(0.0047)	(0.0864)
EDUC	−0.0792	0.6931	−0.2097*	−0.0680
	(0.1362)	(2.5685)	(0.1209)	(2.2342)
CROPAC	0.0000	0.0018	−0.0001	0.0012*
	(0.0001)	(0.0012)	(0.0000)	(0.0006)
MKTADVIS	0.3757***	9.2497***	0.2593**	13.0384***
	(0.1437)	(2.7806)	(0.1220)	(2.0689)
MEANCPRC	−0.1928	−6.5380	—	—
	(0.2498)	(5.4487)		
MEANSPRC	—	—	−0.0245	−4.7339**
			(0.1136)	(2.1008)
PRCRISK	0.2008**		−0.0389	
	(0.0864)		(0.0706)	
RISKWILL	−0.0726		−0.0856	
	(0.0737)		(0.0629)	
FUTURE	0.0399		−0.0164	
	(0.0584)		(0.0481)	
FORWARD	0.3971***		0.4332***	
	(0.0585)		(0.0485)	
LENDER	0.5894***		0.2331*	
	(0.1576)		(0.1198)	
PCTDEBT		7.5859		9.6913***
		(5.3857)		(3.2395)
PCTCNAC		10.8900		—
		(7.2398)		
PCTSBAC		—		3.8725
				(3.8692)
CNINSUR		4.6227*		—
		(2.5839)		
SBINSUR		—		1.6492
				(2.4420)
PCTLVST		−18.5261***		—
		(4.7228)		
NEBRASKA	−0.6175***	0.7121	−0.4386***	0.9969
	(0.1367)	(2.7097)	(0.1401)	(2.7831)
MISSISSIPPI	—	—	−0.4761***	7.9814***
			(0.1332)	(2.5209)
N	604	415	860	697
Chi-square	204.0483	65.0204	183.0619	85.7868
P-VALUE	0.0000	0.0000	0.0000	0.0000

Note: *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

none of the dummy variables for location had significant effects.

When all forms of forward pricing were combined, the results were somewhat different. Age and education had negative effects on the probabilities of forward pricing, and both were statistically significant for soybeans (Table 8). Larger farm size led to lower probabilities of use of forward pricing, although larger farms forward priced higher percentages of expected production. Use of marketing consultants uniformly increased the probability of forward pricing and the percentage forward priced. Although consistently negative for the use and level of forward contracting, expected harvest price was significant only for the percentage of soybeans forward priced. Comfort in forward contracting and the lender's attitude lead to higher probabilities of forward pricing. Greater leverage, crop specialization, and use of crop insurance had positive effects on the level of forward pricing, while percent of farm income from livestock was negative.[6] Location variables had negative effects on the probability of forward contracting but positive effects on the level of use.

Summary and Conclusions

The results of the survey indicate that the level of forward pricing by producers is similar to recent studies. More than 65% of producers had forward priced some of their corn and/or soybean production in the 1995–1998 period. These producers indicated that they would forward price more than 40% of their expected 1999 corn and soybean production, levels, which were somewhat higher than Sartwelle et al. and other previous studies. The majority of producers used forward pricing techniques both before and after harvest. Forward pricing only after harvest was somewhat more common than forward pricing only before harvest. The survey results also suggest that there is a strong tendency for producers to use similar marketing procedures each year. Nearly all the corn producers and over 86% of soybean producers who had forward priced corn or soybeans in the 1995–1998 period expected to use forward pricing with their 1999 production. Over 40% of the producers who had not used forward pricing in the 1995–1998 period would forward price in 1999, suggesting that the percentage of producers who use forward pricing techniques will continue to increase in the future. About half the producers who forward priced in both the 1995–1998 period and 1999 used only forward contracts and did not take direct positions with either futures or options contracts. This is consistent with the findings of Patrick, Musser, and Eckman.

The Heckman two-stage limited information maximum likelihood estimation procedure is used. The selection models are probit models that determine the probability of a producer choosing to forward price using cash forward contracts or taking a direct position in futures or options. The second stages are linear regressions in which the effect of independent variables on the percentage of expected production forward contracted is determined. It was hypothesized that some variables would affect whether a producer used forward pricing but would not have an effect on the quantity of the commodity that was forward priced. Other variables might be expected to affect only the level of forward pricing.

The use of forward pricing has typically been analyzed as an adoption decision. However, some of the findings of this study are not consistent with previous research. Older operators were less likely to use forward pricing, but effects on the level of forward pricing were mixed. In contrast to expectations, education had a negative effect on use of forward pricing but was generally not significant. As the use of forward pricing by producers has increased, the importance of factors typically associated with early adoption may have declined. Size of the farm was hypothesized to have an effect on the use but not necessarily the level of forward pricing. This reflects the

[6] Expansion of availability of crop insurance products such as Crop Revenue Coverage and Harvest-Price Revenue Assurance has significantly changed the potential interactions with forward pricing. Future research in this area should consider these potential interactions and the possible effects of synthetic revenue insurance.

fixed costs associated with the use of a pricing technique being spread over a larger quantity of production. Alternatively, if preharvest pricing increases returns, the marginal return per hour devoted to marketing is larger on larger farms. However, size of farm had no significant effect on the use of forward pricing, while larger farmers tended to forward price at higher levels. Perhaps the fixed costs associated with forward pricing are decreasing as the practice becomes more widely spread.

The use of a market consultant or a computerized information system has a uniformly positive and statistically significant effect on both the use and the level of forward pricing. It is likely that this variable is associated with an awareness of and interest in marketing. This may be useful in identifying potential participants in educational programs about marketing.

Signs on the coefficients of the expected harvest prices are nearly uniformly negative, although there is only very limited statistical significance. As pointed out by a reviewer, this suggests that there may be elements of speculation by producers and merits additional analysis in future research.

Producers who are more concerned about the effect of price variability, are more comfortable in using forward contracts, and have lenders who encourage forward pricing are more likely to use forward contracting. These are variables that may be affected by educational programs. These results suggest that some educational programs should stress increasing a producer's knowledge of the basics of marketing techniques to facilitate their use. Producers who are comfortable with these techniques are likely to participate in additional, more advanced marketing education. The impact of lenders suggests that they can have a role in encouraging producer participation in educational programs.

Percent of gross income from livestock was a variable that was not in the selection model but had the expected sign and was highly significant in determining the percentage of expected corn production that was forward priced. Producers located in Nebraska were significantly less likely than other producers to use forward pricing for either soybeans or corn but did not significantly affect the percentage that was forward priced. In contrast, Mississippi producers are less likely to forward contract soybeans than producers in Indiana or Nebraska, but their level of use is significantly higher. These geographic differences, which are similar to Sartwelle et al., suggest that marketing educational programs will be different in different geographic areas.

The empirical results provide limited support for the hypothesis that forward pricing should be analyzed as an adoption decision. It appears that some variables affect the decision whether to use forward pricing and the level of forward pricing. Other variables, especially those related to risk attitudes, may affect only the decision whether to use forward pricing. Finally, there are variables related to economic position that influence the percentage of expected production that is forward priced.

[Received September 2001; Accepted July 2004.]

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